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ScienceDirect
Journal of Forensic and Legal Medicine 15 (2008) 479–482
JOURNAL OF FORENSIC AND LEGAL MEDICINE
www.elsevier.com/jflm

Original Communication

Prediction of stature using hand dimensions

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Received 20 December 2007; received in revised form 13 February 2008; accepted 6 March 2008
Available online 13 June 2008

Abstract

In this study, an attempt was made to find out possible correlations between hand dimensions and stature using linear and curvilinear regression models for both genders. The study was conducted amongst 250 medical students (125 male and 125 female) aged 18–30 years. Each student has been studied for measurements of stature, hand length and hand breadth. To explain stature, all the explanatory variables like age, sex, hand length (right and left) and hand breadth (right and left) were included for model generation using SPSS. A general linear regression model was found to be best explanatory in both males and females, however, amongst the curvilinear models; the exponential model emerged as the 'best' in explaining stature of the individual. Left hand length alone explained very significantly ($P < 0.001$).

Keywords: Hand length; Stature; Identification; Forensic science; Physical anthropology

1. Introduction

Stature of an individual has an important role in the identification, which is often required in medico-legal practice. Sometimes, fragments of soft tissues are found disposed off in the open, in ditches, or rubbish dumps, etc. and this material is brought to forensic pathologist for examination.[1] The problem of identification mainly arises in these types of cases. Many studies[2–11] have been conducted for assessing stature by anthropometric measurements of different parts of the body. Disaster victim identification (DVI) is another context in which these measurements are useful.

The present study has been conducted to estimate stature by using hand dimensions.

2. Materials and methods

The study was conducted in the Department of Forensic Medicine & Toxicology, SSR Medical College, Mauritius in the year 2005. The material consisted of 250 young and healthy students (125 males and 125 females) in the age group of 18–30 years. Above the age of 18 years, most people attain their maximum growth and therefore attain their maximum length of different body parts.

Height (stature) of the subject was measured in standing posture. The subject was instructed to stand barefooted on the board of a standard stadiometer with both feet in close contact with each other, trunk braced along the vertical board, and head oriented in ear–eye plane by keeping the lateral palpebral commissure and the tip of auricle of the pinna in a horizontal plane parallel to the feet. The measurement was taken in centimeters by bringing the horizontal sliding bar to the vertex.

The hand length was measured as straight distance between distal crease of wrist joint and the most anterior projecting point i.e. tip of middle finger. The breadth of

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1752-928X/$ - see front matter
doi:10.1016/j.jflm.2008.03.002

hand was measured as straight distance from the most laterally placed point on the head of 2nd metacarpal to the most medially placed point located on the head of 5th metacarpal. The measurements were taken by using anthropometric sliding and spreading calipers, and measuring tape.

The entire sample of study, both males and females has been categorized in to three different age groups like: under 20 years, 20–22 years, and above 22 years, and were subjected to statistical analysis. Linear and curvilinear regression equations were formulated separately for each group and also for the entire sample together to find out whether a single equation could be used for all age group or independent equation would be required separately for individual age group to estimate stature. Efforts were also made to formulate multiplication factors and to find out any sex differences.

3. Results

A total of 250 cases (125 males and 125 females) (Table 1) were studied for estimation of stature by hand measurements i.e. hand length and hand breadth.

Table 2 shows descriptive statistics of stature in both the sexes. Mean value, standard deviation and range are presented.

Table 3 illustrates mean value, standard deviation and range of hand length in both males and females.

Table 4 presents mean value, standard deviation and range of hand breadth in both males and females.

Table 1
Age and sex wise distribution of cases

Age group	Males	Females	Total
Under 20 years	35	57	92
20–22 Years	72	61	133
Above 22 years	18	7	25
Total	125	125	250

Table 2
Sex wise distribution of stature

Stature (in cm)	Male ($n = 125$)	Female ($n = 125$)
Mean	173.99	159.56
S.D.	6.13	6.25
Minimum	156.5	144.9
Maximum	190.9	180.2

Table 3
Sex wise distribution of hand length

Hand length (cm)	Male		Female	
	Right side	Left side	Right side	Left side
Mean	18.89	18.90	17.22	17.22
S.D.	0.88	0.87	0.92	0.93
Std. error	0.079	0.078	0.082	0.084
Variance	0.771	0.758	0.847	0.872
Minimum	15.30	15.40	14.80	14.80
Maximum	21.00	20.80	20.40	20.40

Estimation of stature:

For estimation of stature, two models such as linear regression and curvilinear regression were used, which are as follows:

1. General linear regression model for male: To explain for stature, all the explanatory variables like age, left and right hand lengths, left and right hand breadths were included for model generation using SPSS. Two general models came out

Model 1: Stature = 94.835 + 4.187HL left ($r = 0.594$; $R^2 = 0.353$)
Model 2: Stature = 78.992 + 3.365HL left + 3.711HB right ($r = 0.630$; $R^2 = 0.397$)(HL = hand length; HB = hand breadth)

In Model 1, left hand length alone explains very significantly ($P < .001$) for the variation (about 35%) in stature amongst males and the correlation is significantly positive (0.594, $P < 0.001$).

In Model 2, the right hand breadth, in addition to the left hand length, also explains for the variation (about 4% more than in **Model 1**, but still contributing significantly to the model though, $P < 0.01$) in stature.

2. General linear regression model for female: In the case of females, just like for males, two models with the same explanatory variables emerged, i.e.,

Model 1: Stature = 74.404 + 4.945HL left ($r = 0.739$; $R^2 = 0.546$)
Model 2: Stature = 66.366 + 4.031HL left + 3.177HB right ($r = 0.\ 51$; $R^2 = 0.564$)

It is to be noted that, stature is being explained more significantly by left hand length (more than 54% variation explained) as compared to that of males. In the second model, addition of right hand breadth slightly increases the variation explained but is just significant ($P < 0.05$).

3. Curvilinear model per sex category:

a. Male: Stature = 110.120 + exp (0.024HL left) ($R^2 = 0.352$)
b. Female: Stature = 93.876 + exp (0.031HL left) ($R^2 = 0.542$)

Table 4
Sex wise distribution of hand breadth

Hand breadth (cm)	Male		Female	
	Right side	Left side	Right side	Left side
Mean	8.45	8.42	7.48	7.42
S.D.	0.40	0.0	0.38	0.37
Std. error	0.035	0.036	0.034	0.033
Variance	0.157	0.163	0.143	0.138
Minimum	7.30	7.20	6.70	6.60
Maximum	9.40	9.40	8.80	8.70

Table 5
Model summary obtained by regression analysis

Gender	Model	*R*	*R* square	Adjusted *R* square	Std. error of the estimate	Change statistics				
						R square change	*F* change	df1	df2	Sig. *F* change
Male	1	.594[a]	.353	.348	4.95629	.353	67.110	1	123	.000
	2	.630[b]	.397	.387	4.80569	.044	8.830	1	122	.004
Female	1	.739[a]	.546	.542	4.23115	.546	147.690	1	123	.000
	2	.751[b]	.564	.557	4.16256	.018	5.087	1	122	.026

[a] Predictors: (constant), hlenleft.
[b] Predictors: (constant), hlenleft, hbreright.

Linear model best explains for stature, however, amongst the curvilinear models, the exponential model appeared to explain for stature best.

Linear model per age category: Note that the models for both males and females for each age category, i.e., under 20 years; 20–22 years and above 22 years were not consistent with that of the general models, hence were not produced. It is also to be noted that the frequency distribution per age category is not uniform, i.e., we get very few subjects in the categories above 22 years, hence producing a weak model.

4. Discussion

The determination of stature is a vital step in the identification of dismembered remains. Anthropometric techniques are commonly used by anthropologists and adopted by medical scientists to estimate body size for the purpose of identification.[6] Many studies have been carried out to estimate stature by taking measurements of long bones[12–19] and radiographic materials.[20–23]

There are some studies[2–4,7,11] in which an attempt has been made to establish correlation between stature and hand dimensions. This study extends the findings of previous researches by exploring data i.e. hand measurements (length and breadth) and height using linear and curvilinear regression models with sex and age indicator. The dimensions of hands can be successfully used for estimation of stature by law enforcement agencies and forensic experts. These formulae are applicable to the population from which the data have been collected due to inherent variations in these dimensions which may be attributed to biological and environmental factors.[11,24,25]

In the present study, males show higher mean values in each anthropometric dimension as compared to females which may be attributed to the early maturity of girls than boys. As far as bilateral asymmetry is concerned, descriptive statistics do not show any significant asymmetry in both hands as mean value, standard error and variance are all too close. Similar results were obtained by Krishna and Sharma[11] for hand length but their study showed significant asymmetry in hand breadth amongst North Indian population.

A general linear regression model was found to be most promising and validating in both male and female, however, amongst the curvilinear models, the exponential model appeared to best explain for the stature. In case of Males, these individual formulae provide smaller R^2 values. It means the hand measurements are not good enough to explain the variation in stature, especially in males that highlights the importance of biological/environmental factors. It has been also noted that, stature is explained significantly by left hand length alone in both male and female by using linear regression model as well as curvilinear model. Table 5 shows an output of a stepwise regression analysis using SPSS software. It is evident that the left hand length and the right hand breadth are the two main predictor variables explaining for stature in both sexes (from model 2). However, the contribution (based on *R* Square change) of right hand breadth is much less significant as compared to the left hand length. Hence, Model 1 in both genders explains best for stature.

Limitation of study: This study has been conducted on medical students mainly from Mauritius and India. Therefore other studies in different parts of the world are required to confirm whether it would be equally applicable elsewhere.

5. Conclusion

To conclude, the hand length is considered as a prime criterion to estimate stature of a person. The results show significant correlations between stature of an individual and hand length. This equation may be helpful to obtain approximate stature of an individual when there is difficulty in obtaining direct measurement such as in fragmented remains of body.

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